Precision on Track: Survey-grade Imagery and Positioning for Safer, Smoother Railways

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Key words: Deformation measurement; Engineering survey; Geoinformation/GI; GNSS/GPS; Photogrammetry; Positioning; Reference systems; Remote sensing; Risk management; Railway; Imagery; UAV

SUMMARY

Ensuring the safety, sustainability, and efficiency of railway infrastructure depends on timely, survey-grade spatial data. Traditional ground surveys are often costly, risky, and disruptive to operations. This study introduces an advanced UAV-based workflow for railway inspection and mapping, combining high-accuracy aerial imagery with direct georeferencing to deliver sub-centimetre precision while eliminating the need for track access.

The paper presents advancements in railway infrastructure monitoring using ultra-high-resolution Phase One cameras integrated with Trimble Applanix GNSS and inertial systems, achieving millimetre-level ground sampling distances (GSDs) and sub-5 mm positional accuracy with rapid data acquisition and high-definition 3D reconstruction. This level of detail enhances the reliability of AI-driven feature extraction, enabling faster, more consistent detection of infrastructure anomalies. High-efficiency UAV platforms with customized hardware configurations were developed and deployed across multiple projects, demonstrating up to 30% cost savings and 20% faster data collection than traditional methods, all while avoiding service disruption.

The resulting datasets meet Network Rail's Band 1 accuracy requirements and support applications such as track alignment, structural gauging, and digital-twin modelling. This case exemplifies how advanced sensor fusion and streamlined "Pixels to Perception™" workflows can transform railway inspection into a safer, faster, and more sustainable practice aligned with SDG 9 (Industry, Innovation & Infrastructure) and SDG 11 (Sustainable Cities & Communities).

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FIG Congress 2026
The Future We Want - The SDGs and Beyond
Cape Town, South Africa, 24–29 May 2026